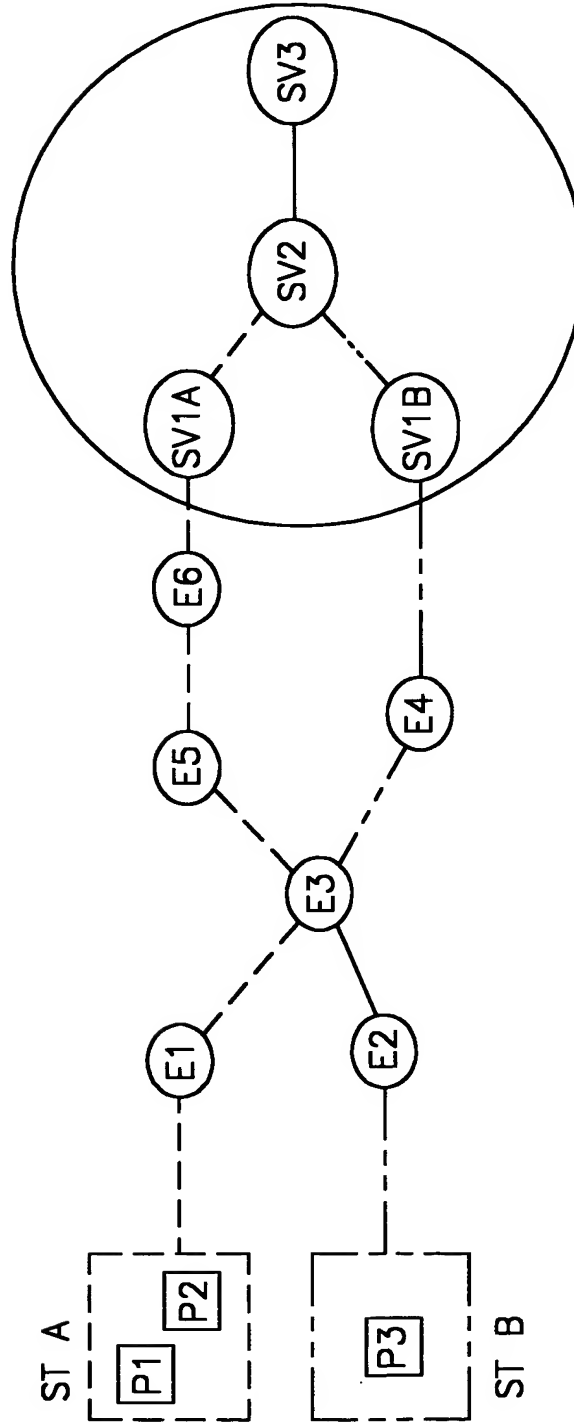




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PROBING TECHNOLOGY

PROBES = TEST TRANSACTIONS (E.G., PING, TRACEROUTE, MAIL-- OR WEB-ACCESS)



ST -- PROBE STATION
P -- PROBE
E -- ELEMENT
SV -- SERVICE

FIG. 1

EXAMPLE
A SINGLE PROBE

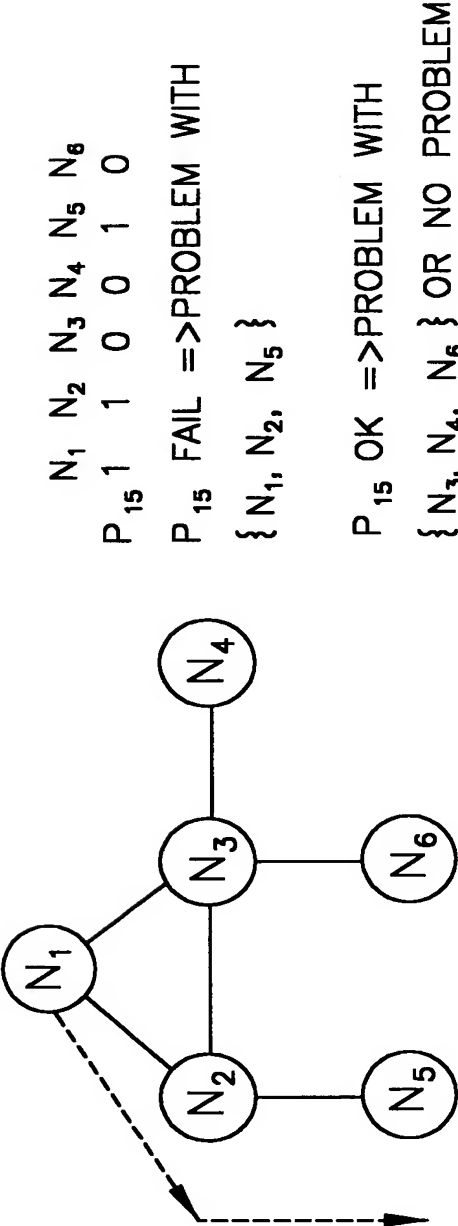
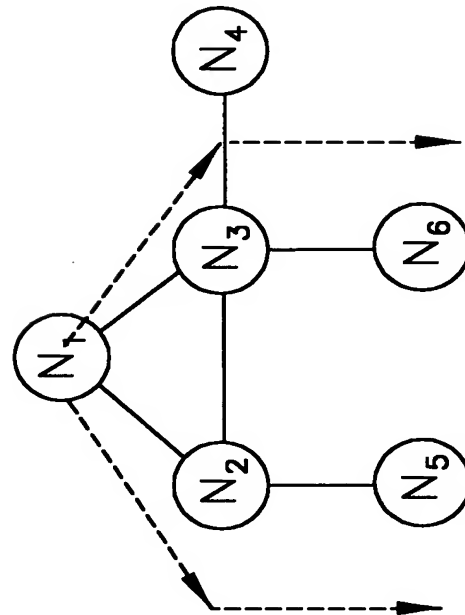


FIG. 2

TWO PROBES – A DEPENDENCY MATRIX



DEPENDENCY MATRIX (rxn)

$$N_1 \quad N_2 \quad N_3 \quad N_4 \quad N_5 \quad N_6$$
$$P_{15} \quad 1 \quad 1 \quad 0 \quad 0 \quad 1 \quad 0$$

P_{16} 1 0 1 0 0 1

FIG. 3

EXAMPLE

PROBE SIGNALS AND DIAGNOSABLE PROBLEMS

"DIAGNOSABLE PROBLEMS" ARE $\{\{N_1\}, \{N_2, N_5\}, \{N_3, N_6\}, \{N_4, \text{NONE}\}\}$

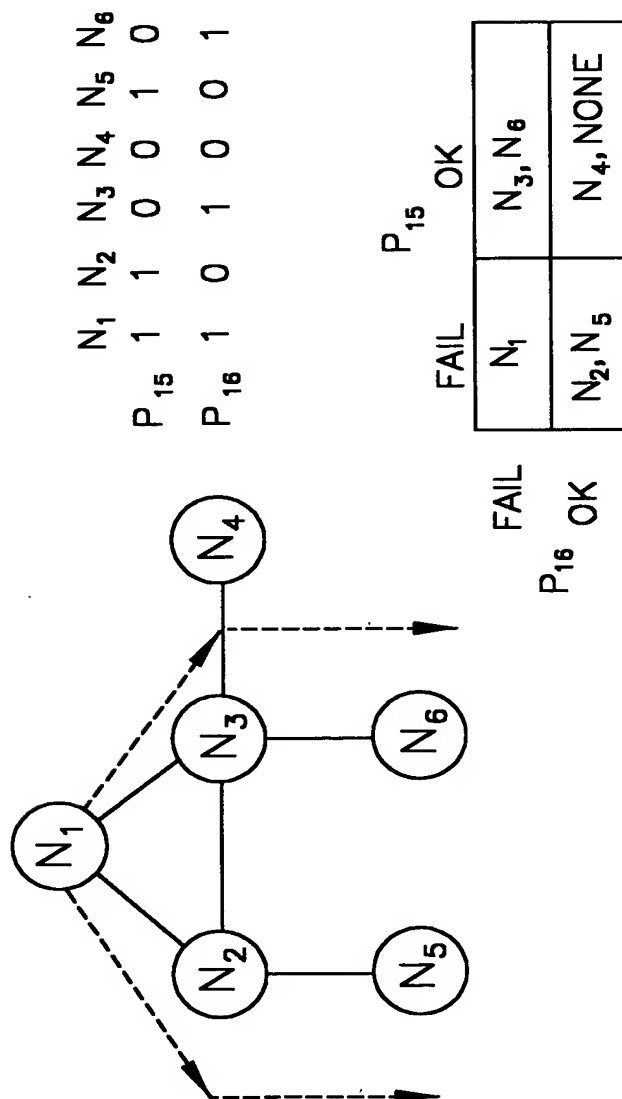
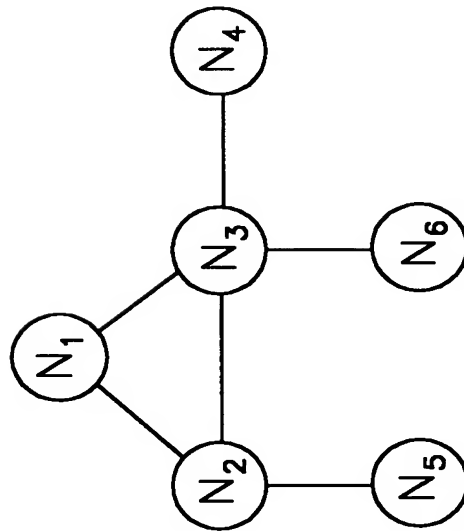


FIG. 4

DIAGNOSING ANY FAILURE
 ALL PROBLEMS DIAGNOSED BY 3 PROBES
 DIAGNOSABLE PROBLEMS ARE $\{\{N_1\}, \{N_2\}, \{N_3\}, \{N_4\}, \{N_5\}, \{N_6\}, \{\text{"NONE"}\}\}$



	N ₁	N ₂	N ₃	N ₄	N ₅	N ₆
P ₁₅	1	1	0	0	1	0
P ₁₈	1	0	1	0	0	1
P ₄₂	0	1	1	1	0	0

N₁ AND N₄ ARE PROBE-STATIONS

FIG. 5

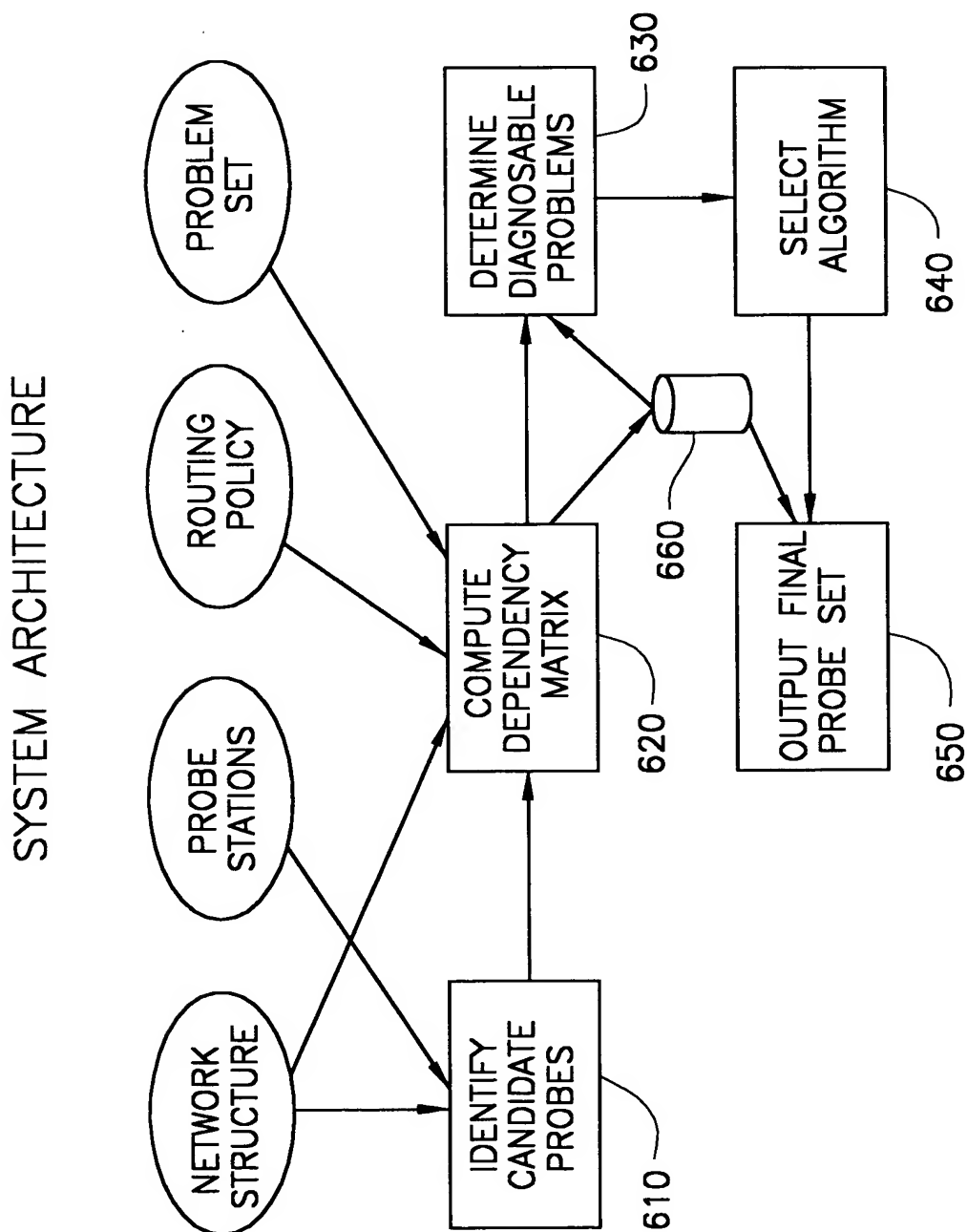


FIG. 6

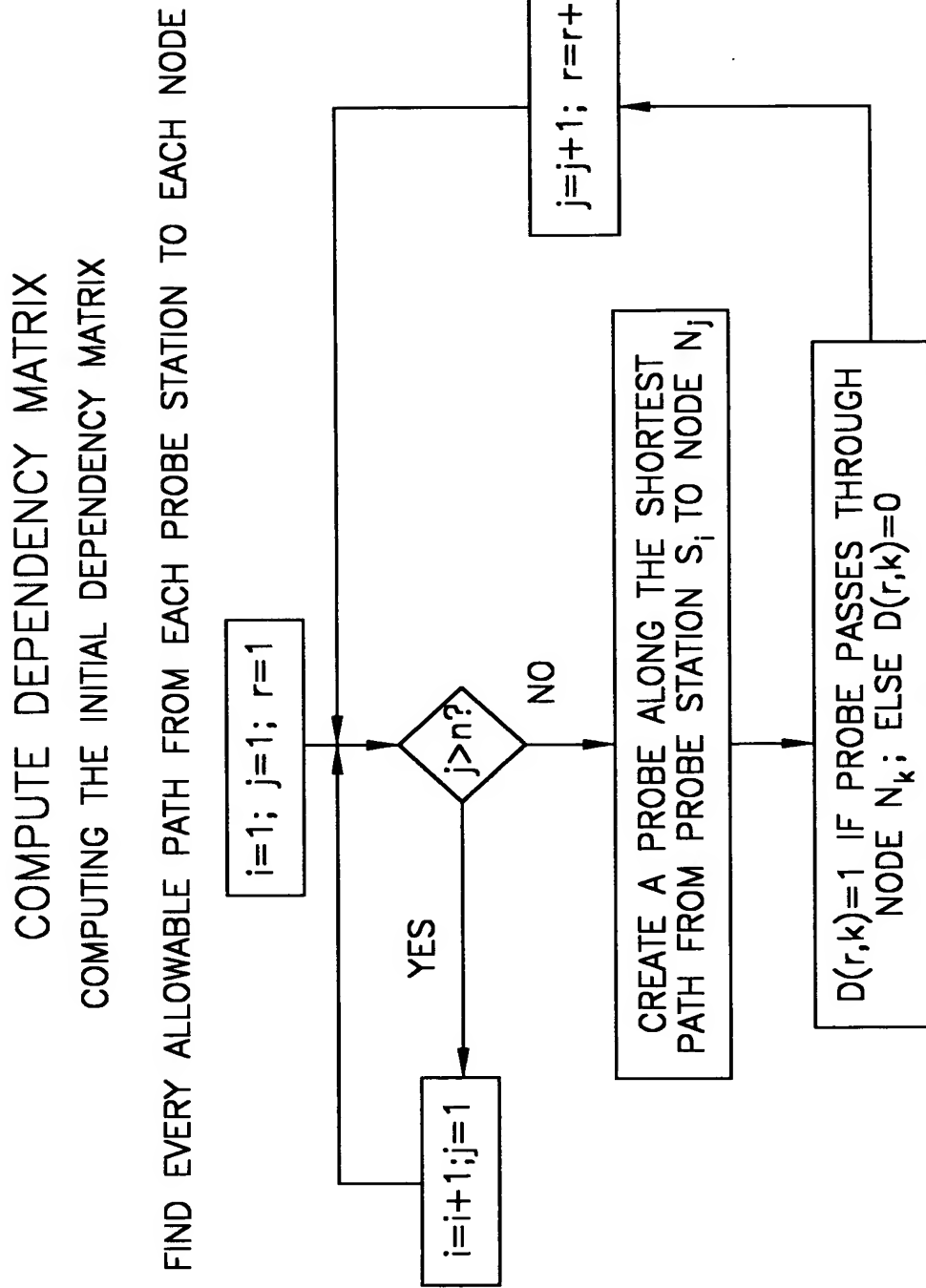


FIG. 7

INITIAL DEPENDENCY MATRIX

AN EXAMPLE OF THE INITIAL DEPENDENCY MATRIX N_1 AND N_4 ARE PROBE-STATIONS - THERE IS ONE PROBE FROM EACH PROBE-STATION TO EACH NODE, FOLLOWING SHORTEST PATH ROUTING.

DEPENDENCY MATRIX (rxn)

	N_1	N_2	N_3	N_4	N_5	N_6	NF
P_{12}	1	1	0	0	0	0	0
P_{13}	1	0	1	0	0	0	0
P_{14}	1	0	1	1	0	0	0
P_{15}	1	1	0	0	1	0	0
P_{16}	1	0	1	0	0	1	0
P_{42}	0	1	1	1	0	0	0
P_{43}	0	0	1	1	0	0	0
P_{45}	0	1	1	1	1	0	0
P_{46}	0	0	1	1	0	1	0

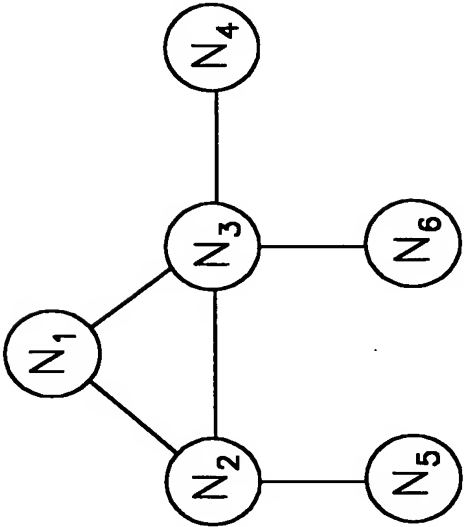


FIG. 8

DETERMINE DIAGNOSABLE PROBLEMS
COMPUTING THE DIAGNOSABLE PROBLEMS OF A PROBE SET

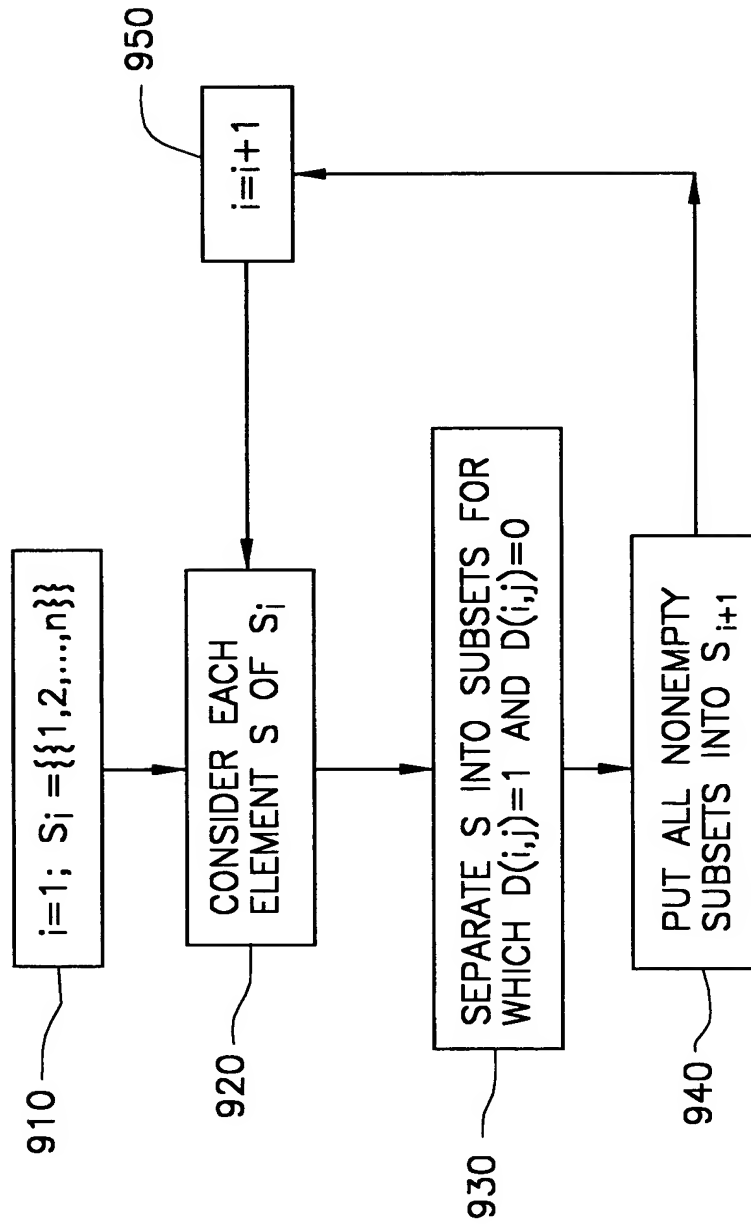


FIG. 9

EXAMPLE
AN EXAMPLE OF COMPUTING THE DIAGNOSABLE
PROBLEMS OF A GIVEN PROBE SET

- (0) $S_0 = \{\{N_1, N_2, N_3, N_4, N_5, N_6, NF\}\}$
- (1)
$$\begin{array}{ccccccc} & N_1 & N_2 & N_3 & N_4 & N_5 & N_6 & NF \\ P_{15} & 1 & 1 & 0 & 0 & 1 & 0 & 0 \end{array}$$
- $S_1 = \{\{N_1, N_2, N_5\}, \{N_3, N_4, N_6, NF\}\}$
- (2)
$$\begin{array}{ccccccc} & N_1 & N_2 & N_3 & N_4 & N_5 & N_6 & NF \\ P_{18} & 1 & 0 & 1 & 0 & 0 & 1 & 0 \end{array}$$
- $S_2 = \{\{N_1\}, \{N_2, N_5\}, \{N_3, N_6\}, \{N_4, NF\}\}$
- (3)
$$\begin{array}{ccccccc} & N_1 & N_2 & N_3 & N_4 & N_5 & N_6 & NF \\ P_{42} & 0 & 1 & 1 & 1 & 0 & 0 & 0 \end{array}$$
- $S_3 = \{\{N_1\}, \{N_2\}, \{N_3\}, \{N_4\}, \{N_5\}, \{N_6\}, \{NF\}\}$

FIG. 10

EXHAUSTIVE SEARCH

EXHAUSTIVE SEARCH TO FIND THE MINIMAL PROBE SET

PROBES THRU(j)=ALL PROBES PASSING THROUGH N_j .

$A \times B$ =ALL SETS CONTAINING ONE ELEMENT FROM A AND A DISTINCT ELEMENT FROM B

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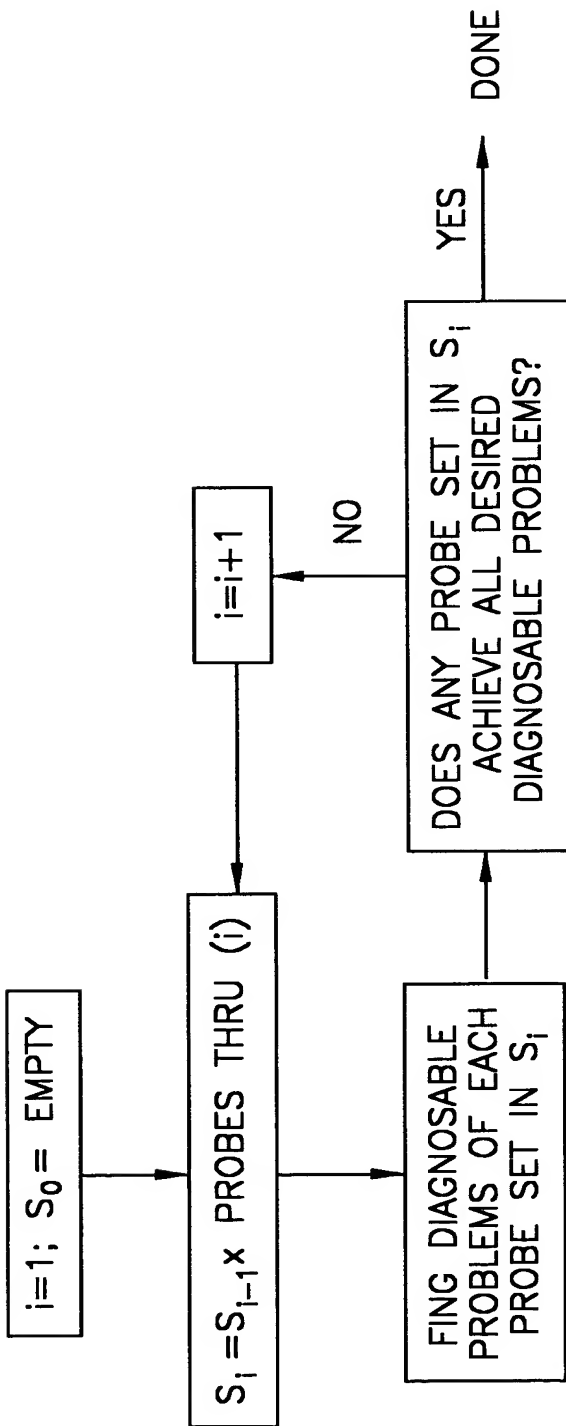


FIG. 11

QUICK SEARCH
QUICK SEARCH TO FIND A SMALL PROBE SET
IDEA: THROW AWAY PROBES THAT ARE NOT NEEDED

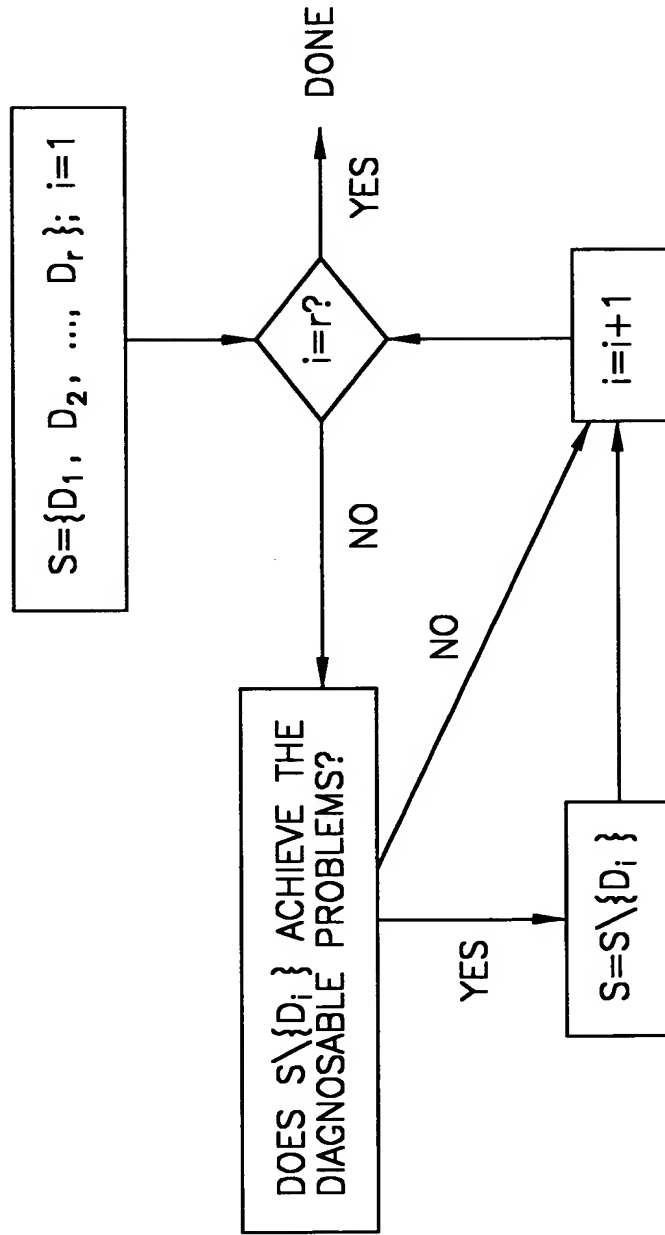


FIG. 12

GREEDY SEARCH

GREEDY SEARCH TO FIND A SMALL PROBE SET
IDEA: ADD THE "BEST" PROBE AT EACH STEP.

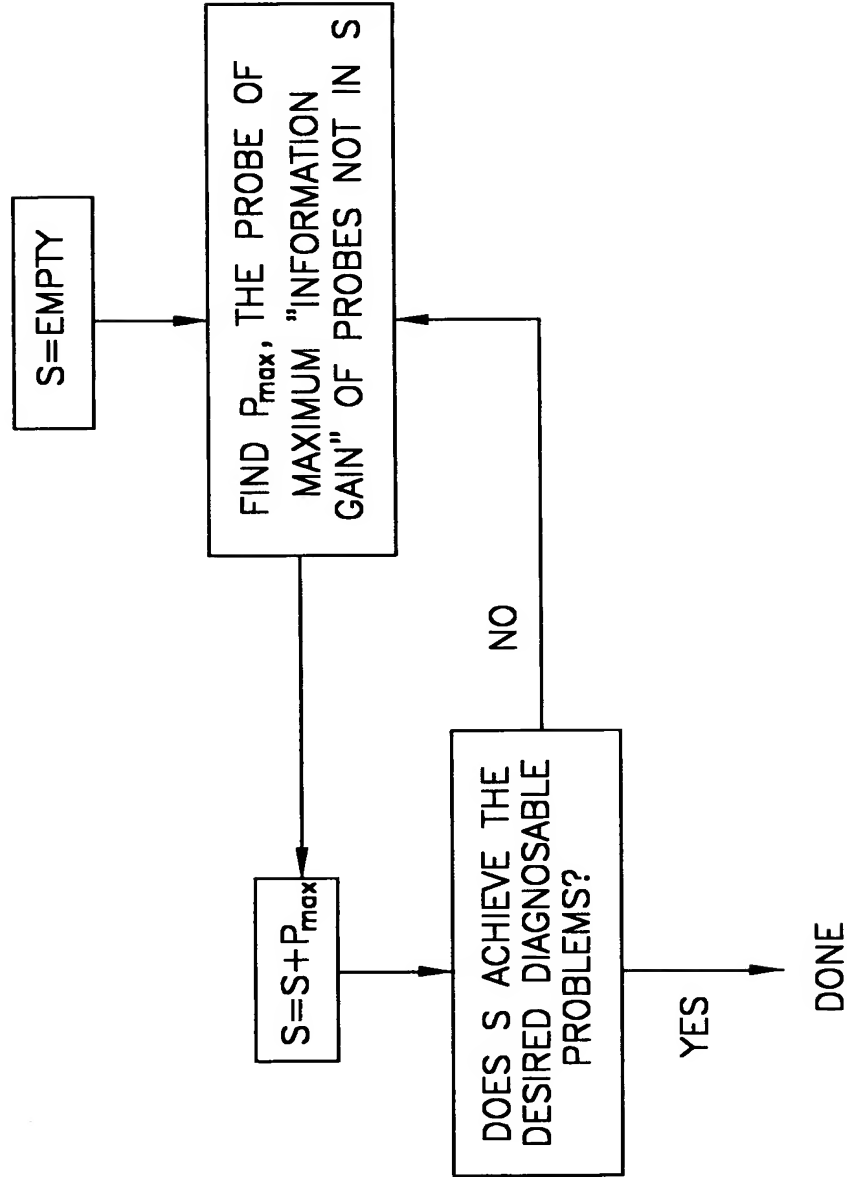


FIG. 13